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A REPORT ON

THE BACTERIOLOGICAL INVESTIGATIONS OF AUTOPSIES.

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presented by the author

Reprinted from the Boston Medical and Surgical Journal of March 21 and 28, and April 4, 1895.

BOSTON:
DAMRELL & UPHAM, PUBLISHERS,
No. 283 WASHINGTON STREET,
1895.

S. J. PARKHILL & CO., PRINTERS
BOSTON

A REPORT ON THE BACTERIOLOGICAL INVESTIGATIONS OF AUTOPSIES.[1]

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In this paper we report the results of the bacteriological study of a large number of autopsies which have been performed at the Boston City Hospital and elsewhere, during a period of about two years prior to January 1, 1895.

This work has been carried on under the direction of Prof. W. T. Councilman, both in the pathological laboratory of the hospital and in the Sears pathological laboratory of the Harvard Medical School.

METHODS OF STUDY.

As a rule, bacteriological examinations have been made from the various organs in every case which came to autopsy, the lung, liver, spleen, kidney and blood of the heart being usually examined. In most cases culture methods only have been used to determine the presence and character of the bacteria in the organs, but in a few instances direct examinations by cover-slip preparations have been employed for this purpose, where this mode of examination has seemed to be adequate.

The culture medium used almost exclusively has been the coagulated blood-serum mixture of Löffler, prepared in tubes in the form of "slants." This medium is prepared by a modification, originated by Dr. F. B. Mallory, of the method generally followed,

[1] This paper will appear in the Boston City Hospital Reports, Sixth Series.

so that large quantities of it can be readily made up in a short time. The special points in this modified method consist in firmly coagulating the Löffler blood-serum mixture (one part one-per-cent. grape-sugar bouillon and three parts beef blood-serum) in the ordinary dry air sterilizer at 80° to 90° C., in the form of slant tubes, and then sterilizing it in the steam sterilizer during three successive days, as in the case of ordinary culture media.

The main difficulty to contend with is the formation of cavities and bubbles in the medium by too great or too rapid heating, so that the smooth surface of the "slant" is destroyed. This can be avoided, however, by securing a thorough and firm coagulation before placing the tubes in the steam sterilizer. Care should also be taken, in the coagulation by dry heat, not to allow the temperature to get above 90° C., or the same formation of cavities may take place. The culture-medium thus prepared is opaque and of a creamy or brownish-white color, resembling in consistency coagulated egg albumin, and presents a smooth, almost perpendicular surface in the tube, upon which there is abundant space for the development of colonies.

The blood-serum used for this medium need not be collected with any special precautions to avoid contamination, and the amount of red blood-corpuscles in it is of little or no importance. The firm coagulation to which this mixture of blood-serum and bouillon is subjected does not seem to impair its nutritive qualities, as might be supposed, for one of us (Wright) has isolated the bacillus tuberculosis upon it directly from tubercular lesions, both in human and in experimental tuberculosis, a fact which is an excellent proof of its efficiency for the cultivation of bacteria.

A further proof of its great value as a culture medium is afforded by the fact that the micrococcus lanceolatus (pneumococcus) and the streptococcus grow

upon it much better and more readily than upon ordinary solid media.

The method of examination of organs by cultures consists in smearing a small amount of the tissue or blood to be examined, over the smooth surface of the culture medium in a tube, by means of a stiff, flattened platinum wire, under the usual precautions, and then placing the culture in the incubator for development. After twenty-four hours the colonies which may have grown out upon the nutritive surface are examined and their character determined.

If the organ is suspected of containing large numbers of bacteria, a second tube may be inoculated from the first one by touching the sterilized platinum wire to the infected surface of the first tube, and then rubbing the infected wire thoroughly over the surface of the second. Since usually only a comparatively few bacteria will be carried over by the platinum wire and distributed over the surface of the media in the second tube, it will be found that in this tube the colonies afterwards developing will be rarely so numerous as to be confluent. If desirable, a third tube may be similarly inoculated from the second, but this is rarely necessary; and, as a rule, one tube is sufficient.

The use of this coagulated blood-serum has greatly simplified the technique of the bacteriological examination of pathological material. It possesses so many advantages over the media usually employed that we have long abandoned the use of any other form of culture at autopsies. These advantages are:—

(1) The fact that the micrococcus lanceolatus and the streptococcus grow on it much better and much more quickly than on ordinary media, such as agar-agar, while the bacillus diphtheriæ grows on it fully as well and quite as characteristically as on the blood-serum medium sterilized fractionally at low temperature, which costs so much labor to prepare.

(2) The ease with which the identification of the bacteria concerned in acute infections can be made; the microscopical examination of the original cultures made at the autopsy being in nearly all cases alone sufficient to establish the identity of the infecting organism, if this is considered in connection with the naked eye appearances of the colonies. For when cultivated on this medium the colonies of the pathogenic bacteria which are ordinarily met with in human pathology present much more characteristic appearances than when grown on agar-agar, so that to a great extent the diagnosis of the bacteria present may be made by microscopic examination alone. Moreover, in cases of poly-infection, or infection with two or more species of bacteria, the estimation of the comparative numbers of the different species is greatly facilitated by the fact that all of the colonies are on the surface, where they can assume their characteristic form, and not, as in agar-plate cultures, for instance, also in the depths of the medium, where their development is impeded, and such an estimation often difficult. We have been able repeatedly to identify with certainty three species of bacteria in a single tube and to form a clear estimate of the relative number of each. The cultural peculiarities of the species above mentioned, when grown on this medium are described elsewhere.

(3) A third advantage is the facility with which the media can be prepared as compared with the agar-agar so generally employed, the preparation of which demands great patience and considerable experience.

(4) Finally, the quickness and simplicity of the method by which cultures on this media are made at autopsies as compared with the usual methods of bacteriological examination by cultures. After a rather extensive experience in bacteriological work, we believe that the plate method and the method of Esmarch roll-tubes have no advantage over this simple method

of successive "smears" when the object is to obtain discrete colonies from an infected organ or to isolate bacteria in pure culture.

Of course, when it is desired to study colonies with a low power of the microscope, the smear method is not to be used; but since in the case of the colonies of the common pathogenic bacteria such study on the usual media gives little information beyond that to be obtained by the naked eye, the simpler methods seem to answer all the requirements in pathological work, especially if blood-serum be the media employed.

METHODS OF BACTERIOLOGICAL DIAGNOSIS.

The main object which we have placed before ourselves in this work, has been the recognition and the identification of the well-known bacteria concerned in the infectious processes which we have met with.

It is now clearly established that the important pathogenic bacteria which we have to deal with in the vast majority of cases of acute infectious disease in man are really few in number and comprise the staphylococcus pyogenes aureus, the streptococcus, the micrococcus lanceolatus, the bacillus diphtheriæ, the typhoid bacillus, and the bacillus coli communis. We have, therefore, devoted our attention towards determining the presence and identity of these species, and have not occupied ourselves with the minute study of the various unknown bacteria which have appeared in our cultures from time to time, for, either their presence could be accounted for by putrefactive processes, or there was no good evidence connecting them with the pathological conditions.

The chief characteristics of these half-dozen forms of pathogenic bacteria upon which we have based their recognition and identification are detailed in the following sections.

THE STAPHYLOCOCCUS PYOGENES AUREUS.

This organism grows on the coagulated blood-serum in the form of golden-yellow to orange colored, slightly elevated, shining colonies, which may in two or three days attain a diameter of several millimetres. The great advantage in the use of this medium for the cultivation of this organism lies in the fact that the characteristic yellow color of its colonies appears immediately and not after several days, as in the case when agar-agar is used as a culture medium.

We have repeatedly recognized the presence of the staphylococcus pyogenes aureus when only a few of its colonies were present in the midst of hundreds of colonies of other bacteria, by means of this yellow color. In our work at autopsies we have not met with any other organism which produces this peculiar color, and so characteristic is it of the staphylococcus pyogenes aureus, when appearing in the cultures from an organ, that microscopic examination is hardly necessary.

The diagnosis of this organism, therefore, depends mainly upon the appearance of its colonies to the naked eye, and these considered in connection with the results of the microscopical examination to determine the morphology of the constituted organisms, are amply sufficient for positiveness. The occurrence of the other variety of the staphylococcus pyogenes, namely, the albus, has been only very exceptionally observed in our studies.

THE STREPTOCOCCUS.

In agreement with the prevalent opinion among bacteriologists we make no distinction between the streptococcus found in erysipelas and that occurring in other conditions; but we consider that but one true species of streptococcus is concerned in human pathology, which, like the bacillus tuberculosis, is capable

of inducing lesions of various forms, the form of lesion depending largely upon the tissue involved, and upon the duration of the infection.

The streptococcus grows on the coagulated blood-serum in the form of minute colonies, but more rapidly and better than upon the ordinary media. These colonies have no definite color, and when numerous are seen as fine grains or as a finely granular appearance on the surface of the medium. On microscopic examination these colonies are found to consist of cocci, in which the chain mode of proliferation may, or may not, be apparent, owing to the breaking up of the chains during the preparation of the cover-glass specimen for examination. Well-marked chains of streptococci can be usually demonstrated, however, in the fluid which is usually present at the bottom of the culture tube. This fluid constitutes essentially a bouillon culture, in which form of culture the organism finds the best conditions for chain formation, as is well known. The diagnosis of the streptococcus rests, then, upon the finding of definite chains of cocci in the culture by microscopical examination, and also upon the growth of these cocci in the form of minute colonies. The only bacterium with which the streptococcus may be confounded is the micrococcus lanceolatus.

THE MICROCOCCUS LANCEOLATUS.

The micrococcus lanceolatus also grows in the form of minute colonies; but these are usually more moist, flatter, more shining, and generally somewhat smaller than those of the streptococcus. The appearance of the colonies is quite characteristic. On microscopical examination the colonies of the micrococcus lanceolatus are seen to consist of pairs of small oval organisms often resembling pairs of small, short, oval, lancet-shaped or conical-ended bacilli. Some variation in

form and size is usually to be noted, and occasionally indications of capsule formation. In the fluid at the bottom of the culture tube longer and shorter chains may be found, which are sometimes very difficult to distinguish from chains of the streptococcus. By careful examination, however, it will commonly be found that the chain of the micrococcus lanceolatus is made up of pairs of oval organisms, while the streptococcus chain is composed of hemispherical cocci. Our diagnosis, therefore, of the micrococcus lanceolatus in cultures rests upon the minute size and the other appearances of its colonies, and the morphology of the organism itself. The pneumococcus may also be identified in the tissues by direct examination of stained preparations, by its morphology and its characteristic capsule. It may be said also that the pathogenic effect of the bacterium exhibiting the characteristics above described, has been repeatedly demonstrated on animals by the production of the characteristic septicemia after subcutaneous inoculation.

THE BACILLUS DIPHTHERIÆ.

The morphology of this organism when cultivated upon the blood-serum, prepared by the rapid method, is quite as characteristic as when this medium, prepared by the ordinary more difficult method, is employed.

We have found this medium especially adapted for determining the presence of the bacillus in the organs of cases dead of diphtheria, because its growth on the coagulated blood-serum is so much more luxuriant and certain than upon agar-agar. In fact we consider that if agar-agar had been used instead of blood-serum in our work on diphtheria autopsies, we should have failed in many cases to have recognized the presence of the bacillus diphtheriæ, when that organism was

found in very small numbers, as is most frequently the case in the viscera.

THE TYPHOID BACILLUS.

The colonies of the typhoid bacillus on the coagulated blood-serum are round, grayish-white disks, often several millimetres in diameter, and are essentially like the colonies of the bacillus coli communis. For the identification of the typhoid bacillus we have not been satisfied with the microscopical examination of its growth on the serum, although this may give important information, if, in the fluid in the bottom of the culture tube, motile bacilli corresponding in morphology to the typhoid bacillus are seen, and the gross appearances of the colonies on the surface of the medium fulfil the requirements, but we have also applied the various tests which serve to distinguish this organism from the bacillus coli communis.

These tests are; the absence of gas-production in sugar-agar or sugar-gelatin cultures; the absence of any appreciable change in the litmus-milk culture; the invisible growth on potato; the absence, or slight amount, of indol production in Dunham's pepton solution; active motility, and facility with which the locomotor organs, or flagella, may be stained by Löffler's method. Another distinguishing point, which we have found constant between the typhoid bacillus and the bacillus coli communis, is the less dense cloudiness of the bouillon culture of the typhoid organism.

THE BACILLUS COLI COMMUNIS.

The colonies of this organism on the coagulated blood-serum are round, shiny, moist, and of no definite color. They grow rapidly and may obtain a diameter of several millimetres. Our experience has shown us that when colonies of this character, made up of short

bacilli of a morphology corresponding to that of the bacillus coli communis, appear in a culture from an organ, they are to be regarded as colonies of that organism almost certainly, and we have generally so considered them. We have satisfied ourselves that the bacillus growing in such colonies is the bacillus coli communis, by subjecting it in numerous cases to most of the various tests for the identification of that organism. These consist in the formation of gas in sugar, gelatin, sugar agar-agar, or in glycerine agar-agar suspension cultures; in the reddening, and usually the coagulation also, of litmus-milk cultures; in the moist, slimy growth on potato; in the usual absence of motility; in the abundant production of indol in Dunham's pepton solution; and in the difficulty of staining the flagella by Löffler's method. The bacillus coli communis has been met with very frequently in the organs of cases of all kinds, both infectious and otherwise. In fact, so frequent has been its occurrence in our cultures that its absence rather attracts attention, and we have ceased to attach much importance to its presence, in most cases at least. From our experience we are of the opinion that the significance of the presence of this bacillus in pathological processes has been greatly overestimated.

For these reasons we have practically ignored the presence of the bacillus coli communis in reporting the results of our work. It should be understood, however, that in the vast majority of cases here reported it has been found in greater or less numbers along with the infecting bacteria in some or all of the organs.

ACUTE LOBAR PNEUMONIA.

It is now generally believed that the micrococcus lanceolatus is the only organism which has any etiological significance in acute lobar pneumonia.

The work of a host of investigators has proven this conclusively, and has further shown that the micrococcus lanceolatus is not only concerned in the causation of the disease, but that it is frequently the infecting organism in other acute inflammatory processes, both in the lung and elsewhere. This organism was first discovered in the salivary secretion by Sternberg and Pasteur in 1880, but it was not until 1886 that Fränkel and Weichselbaum demonstrated the occurrence of the same bacterium in the hepatized lung in the majority of cases, at least, of acute lobar pneumonia.

The early history of the micrococcus lanceolatus and of the bacteriology of acute lobar pneumonia are admirably presented by Welch, in a paper published two years ago.

Welch concludes as the result of his study of the extensive literature on the subject of the bacteria concerned in acute lobar pneumonia and his own observations on fifty cases of the disease, that the micrococcus lanceolatus is undoubtedly its cause. Our own results are in harmony with this conclusion. While in a few instances we have found other pathogenic bacteria in the solidified lung, as others have done, we do not attach any significance to them, for their presence can be usually explained on the ground of secondary infection.

We have never met with the bacillus of Friedländer, which Welch considers as "probably in no way concerned in the causation of genuine acute lobar pneumonia in man."

The occurrence of the micrococcus lanceolatus in the blood and internal organs in cases of acute lobar pneumonia has not received a great deal of attention in the literature. It has been found in the circulating blood, *intra vitam*, by Belfanti in six cases, and by Boulay in two cases. Post-mortem it has been found in the

blood by Pernice and Alessi in two cases, and also by Netter (one case) and Levy (one case) in intra-uterine infection of the fetus with it. In the kidneys in cases of acute lobar pneumonia the micrococcus lanceolatus has been observed by Faulhaber in 29 cases and by Fränkel and Reiche in 22 out of 26 cases. The occurrence in the spleen has been noted by Prior (five cases) and by Sée and Bordas. Welch, in his examination of ten cases, found it in the spleen in four, in the kidney in one, and in the blood of the heart in one case.

In the course of our work bacteriological examinations of the hepatized lung in acute lobar pneumonia have been made in 42 cases, and the presence of micrococcus lanceolatus demonstrated in 38. Among these 42 cases there were four cases of the unresolved or organized form of acute lobar pneumonia, in three of which the micrococcus lanceolatus was found, in one accompanied by the staphylococcus pyogenes aureus, and in another accompanied by both that organism and the streptococcus.

The staphylococcus pyogenes aureus also accompanied the micrococcus lanceolatus in one of the cases of the ordinary form. With the exception of this case and the two cases of organized pneumonia just mentioned, in all of the positive cases the micrococcus lanceolatus has been present alone or associated with the bacillus coli communis, or similar non-significant organisms. In two of the four cases in which the micrococcus lanceolatus was not found, the negative result may be ascribed to the large number of apparently unimportant bacteria which were present, and which may have prevented the development of the feebly-growing micrococcus lanceolatus.

Of the two remaining negative cases, in one the staphylococcus pyogenes aureus and bacillus coli communis were found, and in the other the streptococcus, the

bacillus diphtheriæ and the staphylococcus pyogenes aureus.

In the first case there was coincident a purulent epididymitis with multiple abscesses in the kidneys, and in the second there had been empyema, thoracentesis and general infection with the streptococcus. It seems probable that the abundant growth of the various bacteria found in these two cases in the lung may have obscured the recognition of the micrococcus lanceolatus or prevented its development in the culture, if present.

As to the occurrence of the micrococcus lanceolatus in the various organs in these cases of acute lobar pneumonia, our results may be summed up as follows:

The micrococcus lanceolatus has been found in the liver in 8 out of 26 cases examined; in the spleen in 6 out of 26 cases; in the kidney in 11 out of 26 cases, and in the blood of the heart in 3 out of 11 cases. It is apparent, therefore, that there is more of a general invasion of the blood by this organism than is generally supposed.

PLEURITIDES.

The most extensive investigations of the bacteria concerned in exudative pleuritis are those of Levy, Netter, Koplick, Jakouski, Prince Ludwig Ferdinand and Prudden. The results obtained by these bacteriologists and others have shown that there is no one species of bacteria constantly associated with this condition, but that any of the common pathogenic bacteria and others may be present. From the work of Prince Ludwig Ferdinand and of Prudden, it would appear that cases in which the micrococcus lanceolatus is found have a better prognosis than others.

Of 13 cases of fibrinous pleuritis accompanying acute lobar pneumonia the micrococcus lanceolatus was found in 12, in practically pure cultures in nearly every case, the contaminating organism being usually

the bacillus coli communis. In the single negative case various unknown bacteria were present. In all of four cases of purulent pleuritis coincident with acute lobar pneumonia the micrococcus lanceolatus has been present, in two cases in company with the staphylococcus pyogenes aureus. Of three additional cases of fibrinous pleuritis, not accompanying acute lobar pneumonia, the micrococcus lanceolatus was found in two (in one along with the staphylococcus pyogenes aureus) and the streptococcus in the third case.

Also, in two out of three additional cases of purulent pleuritis, not associated with acute lobar pneumonia, the micrococcus lanceolatus was present, in one case with the streptococcus, and in the other with various unknown bacteria. In the third case the staphylococcus pyogenes aureus was found (culture taken a few hours before death). This was a case of purulent broncho-pneumonia and general infection with the staphylococcus pyogenes aureus.

ACUTE PERICARDITIS.

The bacteriological examinations of the exudate in acute pericarditis recorded in the literature are not numerous.

Weichselbaum has found the micrococcus lanceolatus in several cases; Bainti the same organism in two of three cases; Steinberg in one case; and Thue in four out of five cases. Barbacci in the examination of three cases found the staphylococcus pyogenes aureus in one and the micrococcus lanceolatus in two cases, while Foureur in one case found the streptococcus.

The occurrence of other bacteria in pericarditis have also been reported by Ernst (tubercular pericarditis), and by Paviot.

In seven out of 10 cases of acute pericarditis, seven of which accompanied acute lobar pneumonia, the micrococcus lanceolatus has been present. Of the

three negative cases, in two only the bacillus coli communis was found, while the other case was sterile. In one additional case of acute pericarditis in which no culture was taken from the pericardial exudate, a streptococcus septicemia was demonstrated, so that it is fair to conclude that the pericarditis was due to that organism.

It may also be mentioned that a case of hemorrhagic pericarditis after abortion was negative for specific bacteria.

PURULENT LEPTO-MENINGITIS.

The extensive literature on the subject of the bacteria associated with purulent lepto-meningitis has recently been summarized by Flexner and Barker in their interesting study of epidemic cerebro-spinal meningitis. According to these writers the micrococcus lanceolatus has been found in the great majority of the numerous cases recorded in the literature, while the streptococcus, the staphylococcus pyogenes aureus and other bacteria have been met with in but a small proportion of the cases.

This very frequent occurrence of the micrococcus lanceolatus in purulent inflammation of the pia mater has been observed in the cases examined by Flexner and Barker, as well as in those here reported.

In eight of 11 cases of purulent lepto-meningitis and in one case of the subacute form the micrococcus lanceolatus has been present. The staphylococcus pyogenes aureus accompanied the micrococcus lanceolatus in one of the eight cases of purulent meningitis.

Of the remaining three cases of purulent meningitis, in one the streptococcus was found and two were negative; but one of these negative cases was probably due also to a streptococcus infection proceeding from an otitis media, in the pus of which that organism was present.

Two of the micrococcus lanceolatus cases were secondary to fracture of the base of the skull, the fracture going through the petrous portion of the temporal bone, and thus, by presumably placing the brain cavity in communication with the pharynx, through the Eustachian tube, an infection-atrium for the micrococcus lanceolatus, so common an inhabitant of the throat, was provided. Acute lobar pneumonia was coincident in two of the micrococcus lanceolatus cases and in the negative case. Otitis media was also coincident in one of the same cases.

ACUTE ENDOCARDITIS.

The evidence in favor of the bacterial origin of acute endocarditis is both experimental and pathological.

The possibility of inducing an experimental acute endocarditis, due to bacteria, was first suggested by Rosenbach, in 1878, who showed that by injuring the heart-valves of an animal by means of a sound passed into the carotid, in certain cases vegetations were produced on the valve in which micro-organisms could be demonstrated. These micro-organisms were carried into the circulation accidentally by the operation, and Rosenbach considered that a certain proportion of the heart-lesions resulting was due to their presence and was independent of the mechanical injury produced by the sound. These experiments of Rosenbach opened the way for the later work of Wyssokowitsch and Orth in 1885, who proved that by the injection of the pyogenic cocci into the circulation of animals, after previous mechanical injury to the valves of the heart by Rosenbach's method, a true acute endocarditis could be induced. These investigators maintained that the previous lesion of the valves was necessary, for the mere injection of the pyogenic cocci into the circulation was not followed by the appearance of valvular vegetations, nor did such vegetations appear

after the mechanical injury of the valves, if no bacteria were introduced into the blood. The experimental production of acute endocarditis has also been studied by Netter, Ribbert, Fränkel and Sänger, Prudden, Weichselbaum, Stern and Hirschler, and Viti. The combined results of the work of these writers has shown that true endocarditis can readily be produced in animals by the intravenous injection of any of a number of species of bacteria, provided that there is some previous lesion of the heart-valves, although the necessity of this previous lesion is denied by Netter and Ribbert.

The pathological evidence of the infectious nature of acute endocarditis is also convincing. In 1885 Wyssokowitsch reported finding the staphylococcus pyogenes aureus in a case of ulcerative endocarditis, but failed to find any bacteria in 11 cases of the verrucose form. In the same year Weichselbaum published the results of his study of one case of the verrucose form and three cases of the ulcerative form, in all of which he found either the staphylococcus pyogenes aureus or the streptococcus, or both. The first extensive study, however, of the etiology of acute endocarditis in man, is that of Fränkel and Sänger, published in 1886. These investigators studied 11 cases of the verrucose form and one case of the ulcerative form, and found in nine cases bacteria in the cardiac lesions, the staphylococcus pyogenes aureus being present in six. This publication was important because it was a strong confirmation of the view, which is now generally held, that all forms of acute endocarditis are to be regarded as of infectious origin. An important work also is that of Netter, who observed the micrococcus lanceolatus in seven or nine cases of acute endocarditis associated with acute lobar pneumonia.

Weichselbaum has, however, contributed more to

our knowledge of this disease than any other single investigator. From a study of 15 cases of ulcerative endocarditis, 13 cases of verrucose endocarditis and one case of endocarditis of the left auricle. Weichselbaum concluded that there is no essential difference between the various forms of endocarditis, either histologically or bacteriologically; that no one species of bacteria are concerned in the production of the disease; that in cases in which no bacteria are found, the bacteria have died or there is some defect in the method of examination for their presence; and that chronic endocarditis is the result of the acute form of the disease. Of the 29 cases of Weichselbaum, the micrococcus lanceolatus was found in seven (six of the ulcerative form and one of the verrucose form); the streptococcus in six (four ulcerative and two verrucose); the staphylococcus pyogenes aureus in two (verrucose); and in six cases various unusual bacteria. In eight cases the examination for the presence of bacteria was negative.

Other observations of bacteria in acute endocarditis are those of Banti (20 cases), Viti (eight cases), Girode (six cases), Senger, Lanceraux, Stern and Hirschler, Meyer, Vinay, Steinberg, Malvolz, Tombolan and Fava, Perret and Rodet, Gilbert and Lion, Paulus, Lanceraux and Besançon, Oulmont and Barbier, Lafitte, Josser and Roux, Barbacci, Glusinski, Leyden, Howard and Councilman. The cases studied by these writers prove conclusively that a great variety of bacteria are to be found associated with the acute forms of the disease, in which not only the ordinary pyogenic cocci, the micrococcus lanceolatus and other less known species may be present, but also the gonococcus, (Councilman and others) and the bacillus diphtheriæ (Howard) as well.

In 10 cases of acute endocarditis examinations of the valvular vegetations or ulcerating tissue of the

heart have been made; and in seven of the 10 cases the micrococcus lanceolatus has been found, in one case accompanied by the bacillus diphtheriæ. Of the three remaining cases in which the micrococcus lanceolatus was not found, the staphylococcus pyogenes aureus was present in one, the streptococcus and the staphylococcus pyogenes aureus in the second, and unknown bacteria in the third case. In all, 19 cases of acute endocarditis, six or seven of which were of the ulcerative form, have been studied with reference to the occurrence of bacteria in the internal organs. The micrococcus lanceolatus has been found in the heart-blood or in some or all of the parenchymatous viscera in seven cases. Combining the results of these cultures with the results of the examination of the heart-lesions, mentioned above, it may be said that evidence of the association of the micrococcus lanceolatus with acute endocarditis has been obtained in nine out of the 19 cases. Of the remaining cases, in two there was a well-marked general infection with the staphylococcus pyogenes aureus; in two others, both in puerperal females, a general infection with the streptococcus; and in six no definite conclusion was to be drawn from the results of the cultures. The staphylococcus pyogenes aureus was also present with the streptococcus in the blood of the liver as well as in the valvular vegetation in one of these puerpural cases. It is worthy of note that in a third puerperal case, with acute endocarditis, the micrococcus lanceolatus was found in the blood of the heart and in the embolic pneumonia, while the streptococcus was found in the uterus and kidney.

GENERAL INFECTIONS WITH THE MICROCOCCUS LANCEOLATUS.

In addition to the foregoing cases of general infection with the micrococcus lanceolatus in acute lobar

pneumonia and acute endocarditis, a number of other cases have been met with in which this organism has been found in some or all of the large viscera. These cases are essentially as follows:

Case I. Acute fibrinous pericarditis with effusion. Acute fibrinous pleuritis, acute splenic tumor. Acute degeneration of liver and kidneys. Micrococcus lanceolatus in pericardium, lung, liver and kidney. Spleen sterile.

Case II. Ulcus ventriculi; abscess of adjacent fat tissue with perforation into peritoneal cavity. Fibrinous peritonitis and pleuritis. Micrococcus lanceolatus in fibrinous exudate on peritoneum and pleura, in spleen, kidney and wall of heart. Bacillus coli communis in liver and in some of the other organs also.

Case III. Hysterectomy. Occlusion of ureters by ligature, leakage of urine into peritoneal cavity, congestion of lungs, acute splenic tumor. Micrococcus lanceolatus in peritoneum and spleen. Blood of heart negative. Various bacteria were also present in peritoneum.

Case IV. Acute adenitis of inguinal and peritoneal lymph-glands, acute splenic tumor, edema and congestion of lungs. No infection-atrium demonstrated. Micrococcus lanceolatus in inguinal lymph-gland, kidney and liver. Spleen and femoral lymph-gland sterile. Bacillus coli communis in liver.

Case V. Fracture of base of skull, extending through the petrous portion of the left temporal bone. Acute purulent otitis media (left), purulent leptomeningitis, thrombosis of left lateral sinus, acute splenic tumor, acute degeneration of liver and kidneys. The otitis was apparently subsequent to the fracture. Micrococcus lanceolatus in pus of internal ear and of meninges, blood of heart, liver, spleen, kidney and lung. Staphylococcus pyogenes aureus also in lung.

As elsewhere pointed out, the infection-atrium in this case was most probably the internal ear.

Case VI. Subacute diffuse nephritis (large white kidney), anasarca, ascites, hydrothorax, subacute peritonitis. Micrococcus lanceolatus in peritoneal exudate, spleen, kidney, liver and blood of heart.

Case VII. Disseminated general sarcomatosis. Broncho-pneumonia. Micrococcus lanceolatus in broncho-pneumonia, liver, kidney, and blood of heart. Staphylococcus pyogenes aureus also in kidney. Spleen sterile.

Case VIII. Child, aged two and one-half days. Acute pneumonia of both lungs. Hemorrhages beneath dura and peritoneum. Micrococcus lanceolatus by cover-slips (direct examination) in lung, liver, spleen, kidney and blood of heart. There was no evidence of infection from mother.

Additional cases of general infection with the micrococcus lanceolatus are considered under puerperal infection, diphtheria and scarlet fever.

MISCELLANEOUS GENERAL INFECTIONS WITH THE STREPTOCOCCUS.

In this group we have collected a variety of cases in which the bacteriological examination showed more or less of a general invasion of the viscera by the streptococcus. Some of these cases have been of a surgical character, but a number of others have been cases in which there was little or no reason for suspecting any pyogenic infection, either clinically or at the autopsy. With the exception of a single case, none of the cases with general infection with the streptococcus in diphtheria and scarlet fever are included in this group, but are considered elsewhere in connection with these diseases. The exceptional case was one of diphtheria and scarlet fever in which the streptococcus septicemia

was apparently of surgical origin, and on that account it is included here.

Case I. General arterio-sclerosis, hypertrophy and dilatation of the heart, thrombosis of right auricular appendix, multiple emboli of lungs with infarction, arterio-sclerotic kidney and liver, edema, ascites and hydrothorax. Streptococcus in liver, kidney, spleen, infarction of lung and blood of heart.

Case II. Disseminated tuberculosis of lungs. Tuberculosis of epididymus, seminal vesicles and kidney, acute splenic tumor. Streptococcus in spleen and lungs; in lung, also, bacillus diphtheriæ and staphylococcus pyogenes aureus. Kidney and liver sterile.

Case III. General hematogenous miliary tuberculosis. Primary tubercular ulcer of intestine, tuberculosis of mesenteric glands and thoracic duct. Streptococcus in spleen, liver, kidney, lung, blood of heart and in superficial vein.

Case IV. Cancer of rectum. Streptococcus in kidney, lung and blood of heart.

Case V. Subcutaneous injections of bouillon cultures of the streptococcus derived from erysipelas, in a case of sarcoma of the thigh. Death after about ten days. At the autopsy there was found edema and congestion of the lungs, hemorrhages in parietal and visceral pleuræ, enlargement and congestion of the inguinal glands on the side of the tumor, and of the posterior mesenteric and gastro-hepatic lymph-glands. Streptococcus in tumor, inguinal gland, spleen, liver and blood of heart. Bacillus pyocyaneus in tumor.

Case VI. Broncho-pneumonia, purulent bronchitis, mucopurulent cystitis. Streptococcus in spleen, liver, kidney and blood of heart.

Case VII. Operation for congenital hernia, followed by abscess formation. Diphtheria. This case is included among the diphtheria cases. Streptococcus in liver, spleen, lung and kidney. Bacillus diphtheriæ

in throat, lung and spleen. It seems probable that in this case the infection-atrium for the streptococcus was the operation wound.

Case VIII. Empyema, thoracentesis, croupous pneumonia, acute splenic tumor, fatty degeneration of liver, chronic diffuse nephritis. Larynx and trachea not examined. No suspicion of diphtheria. Streptococcus in kidney, spleen, liver, lung and blood of heart. Bacillus diphtheriæ and staphylococcus pyogenes aureus also in lung.

Case IX. Operation for tuberculosis of hip-joint. Acute peri- and endocarditis. Chronic endocarditis with general chronic passive congestion. Steptococcus in operation wound, liver, spleen, kidney and heart-muscle. Staphylococcus pyogenes aureus also in the operation wound.

Case X. Ulcers and cellulitis of leg, purulent arthritis of knee. Broncho-pneumonia. Fatty degeneration of liver. Acute splenic tumor. Acute degeneration of kidney. Diphtheritic ulceration of large intestine. Streptococcus in knee-joint, kidney, spleen, blood of heart, broncho-pneumonia, and possibly in liver. It is possible that there was a general poly-infection to a certain extent with the streptococcus and the micrococcus lanceolatus, but this was not determined accurately.

Case XI. Operation wound, removal of vermiform appendix, acute purulent peritonitis, broncho-pneumonia, acute parenchymatous degeneration of liver and kidneys. Streptococcus in peritoneal pus, liver and kidney.

PUERPERAL INFECTION.

The present state of our knowledge on the subject of puerperal infection has been recently reviewed by Williams, who concludes "that various, very diverse micro-organisms, especially the streptococcus and the staphylococcus," may be concerned in this condition,

but "that most of the fatal cases of puerperal disease have been due to infection with the streptococcus." Among the first observations of the occurrence of the streptococcus in puerperal infection was that of Orth, in 1873, who described and figured a spherical organism, growing in chains in the purulent exudation of puerperal peritonitis. The first to cultivate this organism from autopsies on puerperal cases was Pasteur, in 1880, and since that time its frequent occurrence in puerperal infection has been demonstrated by Winkel, Pfannenstiel, Czerniewski, and others.

In this group of cases we have included all those cases of infection which seemed to have been of puerperal origin. It will be noted that some of them are well-marked poly-infections.

Case I. Typical diphtheritic endometritis and vaginitis, abscesses in lungs, acute fibrinous pleuritis, acute splenic tumor. Streptococcus in pus of uterine lymphatics, blood of heart and spleen. Streptococcus, staphylococcus pyogenes aureus and micrococcus lanceolatus in lung (abscesses).

Case II. Diphtheritic endometritis and vaginitis, abscesses in lung, acute pleuritis and parotiditis, acute splenic tumor. Criminal abortion at third month. Staphylococcus pyogenes aureus in parotid gland, blood of heart and lung; in the lung, also streptococcus. Liver and spleen sterile. Various unknown bacteria in uterus.

Case III. Fever after childbirth, with intense jaundice. Acute nephritis. Streptococcus in liver, spleen, kidney and blood of heart.

Case IV. Abortion and septic endometritis. Streptococcus in uterus, pus of Fallopian tube, and in spleen. Liver and kidney negative.

Case V. Puerperal fever. Streptococcus in uterus, thrombosed uterine vein and kidney. Other organs not examined.

Case VI. Acute puerperal diphtheritic vaginitis, thrombosis of vaginal veins and uterine lymph-vessels, purulent peritonitis, acute pleuritis, congestion and edema of lungs, acute parenchymatous degeneration of liver and kidney. Congenital defect in intra-ventricular septum, patency of foramen ovale, hypoplasia of aorta; chronic passive congestion of lungs. Streptococcus in abdominal pus, pleural exudate and blood of heart. Staphylococcus pyogenes aureus in spleen. Bacillus coli communis in uterine lymph-sinus, vaginal veins, kidney and in some other situations.

Case VII. Hemorrhagic pericarditis, uterine hemorrhage, abortion in progress. Bacillus coli communis in body of uterus, kidney, blood of heart and spleen. Liver sterile. Pericardium negative.

Case VIII. Puerperal septicemia, partially retained placenta, acute splenic tumor, acute parenchymatous degeneration of liver and kidneys. Streptococcus in kidney. Bacillus coli communis in uterus, liver, spleen, kidney and blood of heart.

Case IX. Acute lobar pneumonia following childbirth. Streptococcus in uterus and kidney. Micrococcus lanceolatus in lung and pleural exudate. Bacillus coli communis in all organs.

Case X. Hypertrophy of uterus after early abortion. Endometritis, acute endocarditis, hemorrhagic infarction of lungs with embolic pneumonia, acute splenic tumor. Micrococcus lanceolatus in blood of heart and lung. Streptococcus in uterus and kidney. Bacillus coli communis in liver and in other organs.

Case XI. Acute endometritis. Post-partum hypertrophy of uterus, acute endocarditis, septic infarction of spleen and kidneys, embolism of branches of superior mesenteric artery, subacute nephritis, slight chronic passive congestion of lung, liver and spleen. Streptococcus in endometrium, liver, kidney, spleen infarc-

tion. Streptococcus and staphylococcus pyogenes aureus in heart-lesion and blood of liver vein. Spleen sterile.

Case XII. Clinical diagnosis: puerperal eclampsia. Post-partum hypertrophy of uterus, laceration of cervix with hemorrhage into ligamentum latum. Hydrothorax, hydro-pericardium, edema of lungs, acute splenic tumor. Micrococcus lanceolatus in endometrium, liver, lung, spleen and kidney.

The streptococcus has been found in one or more of the internal organs in nine of these twelve cases. This result is in harmony with the generally accepted view that this organism is by far the most common cause of puerperal infection.

ERYSIPELAS.

Case I. Erysipelas of face, pulmonary apoplexy, acute splenic tumor. Old tuberculosis of apices of lungs, scattered foci of tuberculosis in the upper lobe of right lung, acute tubercular pleuritis left side. Streptococcus in tissue of face. Staphylococcus pyogenes aureus also in tissue of face and in spleen, kidney and lung and blood of heart. Liver negative.

Case II. Erysipelas of face and neck. Acute nephritis. Cultures failed to demonstrate any specific infection.

Case III. Erysipelas of face and scalp, congestion of lungs, acute splenic tumor. Steptococcus and other organisms in scalp. Liver and spleen sterile. Various bacteria in blood of heart and lateral sinus. Staphylococcus pyogenes aureus in lung.

Case IV. Erysipelas of face and scalp. Diffuse visceral syphilis. Streptococcus in blood of heart, spleen and lung. Bacillus coli communis in kidney.

Case V. Erysipelas of face. Contusion of forehead and buttock. Fatty degeneration and purulent infiltration of muscles of buttock. Streptococcus in

muscles of buttock, spleen, kidney, liver, lung and blood of heart.

Case VI. Erysipelas of leg; small ulcer on posterior surface of leg. Inguinal glands on affected side enlarged and reddened, and in the adjacent tissue small purulent foci. Hypostatic congestion of lungs, acute splenic tumor. Streptococcus in the deep subcutaneous tissue of leg and inguinal gland. Micrococcus lanceolatus in lung. Bacillus coli communis in kidney and blood of heart.

Case VII. Erysipelas of leg. Broncho-pneumonia. Tissues of leg and inguinal gland sterile. Streptococcus in liver. Staphylococcus pyogenes aureus inlung, kidney and spleen. Blood of heart sterile.

It will be seen that the streptococcus has been found associated with six of these cases, while in two there was a general infection with the staphylococcus pyogenes aureus in addition. We consider the general infection with the latter organism as a secondary one, following on the erysipelas, which was induced by the streptococcus. The failure to demonstrate the streptococcus in the local lesion in one of the cases in which that was examined, is not surprising, as it is well known that it does not long survive in the tissue after it has produced its effects.

We have examined four cases of extensive superficial burns which we will consider in one group. The bacteriological results are as follows:

Case I. Streptococcus in spleen, kidney and blood of heart. Liver and mesenteric gland sterile.

Case II. Streptococcus in suppurating tracheal gland, liver, spleen and kidney.

Case III. Bacillus coli communis in spleen, kidney and lung. Liver and blood of heart sterile.

Case IV. Various unknown bacteria found in the various organs.

GENERAL INFECTIONS WITH THE STAPHYLOCOCCUS PYOGENES AUREUS.

In this group we consider those cases in which the bacteriological examination showed a general mono-infection essentially with the staphylococcus pyogenes aureus. One of the cases of diphtheria is included here because the general infection with the staphylococcus seemed to have its origin in an operation wound of the hip, rather than in the throat. We also report here more in detail the two cases of endocarditis with staphylococcus septicemia.

Case I. Infection-atrium a decubitus over the scapula. Edema and hypostatic congestion of lungs. Acute splenic tumor. Arterio-sclerosis of aorta and heart hypertrophy. Staphylococcus pyogenes aureus in spleen, lung, liver and kidney and cerebral meninges. Streptococcus and micrococcus lanceolatus in lung.

Case II. Oöphorectomy for cancer. Metastases in retro-peritoneal lymph-glands, omentum and liver. Circumscribed peritonitis. Acute splenic tumor. Chronic diffuse nephritis. Chronic pleuritis with effusion. Hypostatic congestion and edema of lungs. Staphylococcus pyogenes aureus in kidney and blood of heart.

Case III. Laparotomy for chronic salpingitis, slight peritonitis. Soft spleen. Staphylococcus pyogenes aureus in the peritoneum, spleen and blood of heart.

Case IV. Operation for congenital dislocation of hip. Abscess about hip-joint extending around ileum, beneath peritoneum, up to the kidney. Secondary abscess in left shoulder, kidney and lung. Diphtheria. Staphylococcus pyogenes aureus in primary abscess, kidney, spleen, liver and lung. Bacillus diphtheriæ in air-passages and lung.

Case V. General infection with actinomyces. The cultures showed a general infection with staphylococcus pyogenes aureus also. This case is fully reported elsewhere by Dr. Mallory.

Case VI. Carbuncle of upper lip, metastatic abscesses of lung and kidney. Acute endocarditis, acute splenic tumor, acute hyperplasia of cervical and mesenteric lymph-glands. Acute parenchymatous degeneration of liver and kidneys. Acute degeneration of heart-muscle. Staphylococcus pyogenes aureus in carbuncle of lip, kidney, spleen, liver. lung, pericardium and blood of heart.

Case VII. Pyo-pneumothorax, perforation of diaphragm. Extensive purulent excavation of liver, general peritonitis. Pleural effusion (left side), fatty degeneration of liver. Staphylococcus pyogenes aureus in remnants of lung, liver substance, liver pus and in kidney.

Case VIII. Acute ulcerative endocarditis, acute pericarditis, infarction of kidney, unresolved pneumonia, empyema, chronic passive congestion. General hypertrophy and dilatation of heart. General edema of connective tissue. Staphylococcus pyogenes aureus in heart-lesion, spleen, kidney, kidney infarction, liver and blood of heart.

Case IX. Purulent broncho-pneumonia, empyema of one side, broncho-pneumonia and acute pleuritis of other side. Multiple miliary abscesses in kidney. Staphylococcus pyogenes aureus in lung (purulent broncho-pneumonia), liver and spleen. Kidney abscesses sterile.

Case X. Acute alcoholismus. Congestion of lung and stomach. Acute splenic tumor. Acute parenchymatous degeneration of liver. Staphylococcus pyogenes aureus in lung, liver and kidney. Spleen sterile. Pneumococcus also in lung. A mouse, inoculated with an impure culture of the pneumococcus

found in the lung, died in forty-eight hours with typical encapsulated diplococci in the blood.

ANOMALOUS GENERAL POLY-INFECTIONS.

Under the head of anomalous general poly-infection we group certain of the cases in which the staphylococcus pyogenes aureus and the streptococcus, or either of these organisms and the micrococcus lanceolatus, have been found together in the same case in some of the internal organs other than in the lung. The poly-infections of this character which have been observed in diphtheria, scarlet fever, erysipelas and puerperal cases are not included in this group, but are considered elsewhere.

Case I. Cirrhosis of liver, chronic interstitial nephritis, dilatation of right ventricle of heart, fibrous myocarditis, general chronic passive congestion, ascites and hydrothorax. Staphylococcus pyogenes aureus in liver and kidney. Streptococcus and staphylococcus pyogenes aureus in spleen. No cultures from lung and heart.

Case II. Extreme hemoglobinemia, hemoglobinuria, icterus, acute splenic tumor, acute fatty degeneration of heart-muscle. Micrococcus lanceolatus and staphylococcus pyogenes aureus in kidney. Micrococcus lanceolatus and streptococcus in lung. Streptococcus in liver. Spleen sterile. Unknown bacteria in blood of femoral vein.

Case III. Meningitis purulenta, secondary to otitis media. Acute splenic tumor. Streptococcus in pus of otitis and in liver. Staphylococcus pyogenes aureus in kidney and lung. Bacillus coli communis in blood of heart. Spleen sterile.

Case IV. Acute lobar pneumonia, acute pleuritis, acute splenic tumor, urinary fistula, abscess of kidney, acute degeneration of kidneys, cirrhosis of liver, arteriosclerosis of aorta and coronary arteries, atrophy of

pancreas. Streptococcus in liver, staphylococcus albus (?) in kidney, large coccus in spleen. Various bacteria in lung.

Case V. Chronic diffuse nephritis (fatty kidney). Edema of brain and lungs, arterio-sclerosis of coronary arteries, mico-purulent bronchitis, acute splenic tumor. Micrococcus lanceolatus and streptococcus in liver. Micrococcus lanceolatus in kidney and spleen. Blood of heart negative. A mouse, inoculated with the mixed culture from the liver, died in about forty-eight hours with a streptococcus septicemia, as shown by cultures from the organs.

Case VI. Chronic coxitis with suppurating foci, peritonitis with serious exudation, fibrinous focal pneumonia left lung, subacute nephritis and general amyloid infiltration. Micrococcus lanceolatus in peritoneal exudate, lung and kidney. Streptococcus in liver, spleen, and also in kidney.

Case VII. Bronchiectatic abscesses in lungs, organized pneumonia, subacute pleuritis with pus formation. Acute splenic tumor. Subacute nephritis. Micrococcus lanceolatus and staphylococcus pyogenes aureus in lung, pleural-pus and kidney. Staphylococcus pyogenes aureus in liver. Spleen sterile.

Case VIII. Acute lobar pneumonia, acute fibrinous pleuritis. Acute splenic tumor. Micrococcus lanceolatus and staphylococcus pyogenes aureus in lung, liver, kidney and blood of heart. Micrococcus lanceolatus in pleura, spleen and blood of femoral vein.

DIPHTHERIA.

Up to the time of the well-known work of Frosch, it was generally believed that the *bacillus diphtheriæ* never invaded the internal organs, but was only to be found in the local inflammatory lesions. In ten out of fifteen autopsies on this disease, this investigator,

by using large amounts of material for each culture, could demonstrate the presence of the bacillus either in the blood or in some of the organs. One of the most frequent situations in which it was found was in the pneumonic areas of the lungs. Previous to the work of Frosch but a very few instances are on record in which the bacillus has been met with in these situations. One of these is its occurrence in the spleen in a case reported by Kolisko and Paltauf. In the cervical lymph-glands it has been observed by Schmorl in seven out of ten cases. Recently Booker obtained it in cultures from the spleen, submaxillary gland, lung and blood of the heart in a case of diphtheria, and Kutcher observed it once in the liver and once in the kidney.

In the broncho-pneumonia of diphtheria the presence of the bacillus diphtheriæ was noted by Thaon in 1885, but its occurrence in this common complication of the disease does not seem to have received much attention until the last few years, during which time Johnston found it in a single case, Strelitz in one case out of eight, Flexner in one of two cases, Mosny in one of three, Kutcher in eight out of nine, while the frequency of its occurrence in the cases examined by Frosch, has been already mentioned. Of other bacteria associated with the broncho-pneumonia of diphtheria, the work of Thaon, A. Fränkel, Prudden and Northrup, Mosny and Netter, shows that the streptococcus is to be met with in the great majority of cases. In the two cases reported by Flexner, however, the micrococcus lanceolatus was present, and of the eight cases of Strelitz's, the same organism was present in five, in three of which it was accompanied by the pyogenic cocci.

The occurrence of a poly-infection in certain cases of diphtheria with both the specific bacillus and the streptococcus has been insisted upon by Barbier. This

writer holds that there exist two forms of the disease, one a pure mono-infection with the bacillus diphtheriæ, the other a poly-infection with that organism and the streptococcus, or various (doubtful) varieties of it. This conclusion is based mainly upon the results of the bacteriological examination of the throat during life. The post-mortem demonstration, however, of the presence of pyogenic cocci in the internal organs has apparently been made in but a few cases.

Geneserich, in an examination of twenty-five autopsies on cases of diphtheria of different clinical types, found among these, four cases of invasion of the blood and internal organs with the streptococcus, while in many cases a general infection with the staphylococcus pyogenes albus was observed.

Bacteriological examinations of the various internal organs have been made in 31 cases of diphtheria, in 5 of which scarlet fever was coincident, and in another case typhoid fever. The bacillus diphtheriæ has been found by culture in the lung in 30 out of 31 cases examined, in the liver in 9 out of 29 cases, in the kidney in 6 out of 31, in the spleen in 5 out of 31, in the blood of the heart in 5 out of 26, in the mesenteric lymph-glands in 7 out of 16, in the cervical lymph-glands in 4 out of 9, in the bronchial lymph-glands in 2 out of 3, in the brain tissue in 2 out of 5 cases, and in the mucous membrane of the stomach in 3 cases. In 21 of the 31 cases, or in nearly 70 per cent., there has been found a more or less general invasion of the internal organs by the pyogenic bacteria, of which the streptococcus was the one most frequently met with.

The streptococcus was present in one or more of the large viscera (exclusive of the lungs), or in the blood of the heart, or in both, in twenty cases. In five of these cases, in addition to the streptococcus in certain organs, the staphylococcus pyogenes aureus or

the micrococcus lanceolatus, or both, have been found also in some of the organs of the same case.

Among the streptococcus septicemias was the case of diphtheria and typhoid fever reported by Morse, in which the typhoid bacillus was also found in the various viscera. The only case of pyogenic infection in diphtheria in which the streptococcus was not concerned, but in which the staphylococcus pyogenes aureus was cultivated from all the large viscera, was one with a recent operation wound about the hip-joint, which should be regarded as the probable infection-atrium for the staphylococcus. Because of its unusual features, this case should be excluded from consideration as an ordinary case of poly-infection in diphtheria, as should also be excluded for the same reason, one of the cases of general streptococcus infection, in which the infection-atrium was probably a recent operation-wound in the abdominal wall with abscess formation. Excluding, therefore, these two surgical cases, there still remain nineteen cases of poly-infection in which the infection with the bacillus diphtheriæ was complicated by infection with the pyogenic bacteria.

This fact is of importance in connection with the treatment of diphtheria with antitoxin, for while the antitoxin is certainly capable of neutralizing the effects of the diphtheritic poison under certain conditions, yet there is no evidence that it can neutralize the effects of the pyogenic infection as well. If it is generally true that 60 per cent. of all cases die with a general infection with the pyogenic cocci in addition to the infection with the bacillus diphtheriæ, the failure of the antitoxin to effect a cure in a certain proportion of cases can be readily understood. It will be interesting to observe in future, when the antitoxin treatment has come into general use, whether many cases of pure uncomplicated diphtheria come to autopsy as at present.

Of the thirty-one cases, broncho-pneumonia was present in nineteen. The cultures from the lung in these broncho-pneumonias gave the following results:

The bacillus diphtheriæ (not accompanied by other pathogenic bacteria) in eight cases. The bacillus diphtheriæ and the streptococcus in five cases; the bacillus diphtheriæ, the streptococcus and the staphylococcus pyogenes aureus in two cases; the bacillus diphtheriæ, the streptococcus, the staphyloccus pyogenes aureus and the micrococcus lanceolatus in one case; the bacillus diphtheriæ and the staphylococcus pyogenes aureus in one case; the streptococcus (not accompanied by other pathogenic bacteria) in one case, and the bacillus diphtheriæ, the streptococcus and the micrococcus lanceolatus in one case.

From these results it is apparent that no one organism is to be regarded as the cause of the broncho-pneumonia of diphtheria. In fact, some or all of these species of bacteria above mentioned may be present in the lungs without the occurrence of broncho-pneumonia, as the following results show. Of the twelve cases in which no pneumonic condition was present, the cultures from the lungs in six cases (including two cases of pulmonary infarction) showed the presence of the bacillus diphtheriæ as the only pathogenic organism present, in two cases the bacillus diphtheriæ and the streptococcus, in two cases the bacillus diphtheriæ and the staphylococcus pyogenes aureus, and in two other cases the bacillus diphtheriæ, the streptococcus, the staphylococcus pyogenes aureus and the micrococcus lanceolatus.

Undoubtedly a large portion of the bacteria developing in the cultures from the lung are derived from the smaller bronchi, and not from the lung substance proper.

An interesting case, not included in our cases of diphtheria above analyzed, in which the bacillus diph-

theriæ was found, may be referred to here. The case was essentially one of broncho-pneumonia in an old man, no other well-marked lesions being made out at the autopsy, although the larynx and trachea were not examined. There were no symptoms during life. The cultures showed the presence of typical forms of the bacillus diphtheriæ in the lung and liver, in addition to various unknown bacteria. The organism, however, both from the lung and liver, was found to have no virulence towards guinea-pigs. This lack of virulence towards guinea-pigs has been occasionally observed in the bacillus diphtheriæ. We have noted it ourselves in a number of instances, even when the bacillus was derived from fatal cases of diphtheria. In addition to this case we have also met with the bacillus diphtheria in the lung in two other cases, in one of which it was found to be typically virulent towards a guinea-pig. In neither of these cases was there any suspicion of diphtheria during life and the air-passages were not examined at the autopsy.

SCARLET FEVER.

Crooke, in 1885, found micrococci in the spleen and kidneys of 30 cases of scarlet fever; and in the same year Fränkel and Frendenberg found the streptococcus in cultures or sections from the submaxillary glands, the liver, the spleen and kidneys in three cases of the disease. Raskin observed the streptococcus in the purulent lymph-glands and joints, and four times in the blood of the heart in scarlet fever; and Leubartz examined a case with similar results. In the kidneys, in scarlatinal nephritis, Babes obtained constantly the same organism. The occurrence of a streptococcus general infection has also been constantly observed by Kurth at autopsies on scarlet fever.

Autopsies have been performed on 11 cases of scarlet fever, in five of which diphtheria was coincident.

A well-marked general infection with the streptococcus was demonstrated in four cases (diphtheria being coincident in two); a general infection with the micrococcus lanceolatus in one case; and in another case a general poly-infection with the micrococcus lanceolatus, and the staphylococcus pyogenes aureus; these bacteria being found in the various organs either separately or together. In still another case, in which diphtheria was coincident, the culture from the spleen showed the presence of the micrococcus lanceolatus, and that from the kidney, both the streptococcus and the staphylococcus pyogenes aureus.

In the four remaining cases the cultures from the various organs (exclusive of the lungs) were sterile, or contained various unknown bacteria; and no general pyogenic infection could be demonstrated. It may be mentioned that diphtheria was coincident in but three of the seven cases of general infection with pyogenic cocci. Broncho-pneumonia was observed in nine of the eleven cases. The cultures from the lung in these cases resulted as follows:

The streptococcus was found in four cases (including two cases of coincident diphtheria in which it was associated with the bacillus diphtheriæ); the bacillus diphtheriæ in two cases; the micrococcus lanceolatus in one case; the micrococcus lanceolatus and staphylococcus pyogenes aureus in one case; and in one case a mixture of three of these species of bacteria. It is apparent, therefore, that no one species of bacteria is to be found constantly in the broncho-pneumonia of scarlet fever. This has also been shown to be true of the broncho-pneumonia of diphtheria.

TYPHOID FEVER.

But nine cases of typhoid fever have come to autopsy. The chief points of interest in our study of these cases may be briefly given as follows: The typhoid bacillus

has been found in the spleen in seven of the nine cases. In the two negative cases the failure to find the bacillus may be explained by the fact that both cases had entered the stage of healing. This early disappearance of the typhoid bacillus is interesting. It is worthy of note that in one of these cases an acute endocarditis (micrococcus lanceolatus) was present. In two cases there was a poly-infection with both the typhoid bacillus and the streptococcus, diphtheria being coincident in one of them. As to the distribution of the typhoid bacillus through the organs other than the spleen, our observations are not as complete as could be desired. Our results on this point may be summarized as follows: The typhoid bacillus has been found in the liver in four out of seven cases in which cultures were made from that organ; in the kidney in three out of seven cases; in the blood of the heart in two out of four; in the mesenteric gland in three out of five cases; and in the bile in two out of three cases.

In the identification of the typhoid bacillus and its differentiation from the bacillus coli communis, great care was exercised, the liability of confusing it with that organism being always borne in mind. The typhoid bacillus in these cases was differentiated from the bacillus coli communis by the absence of gas production in its sugar-agar culture, by the appearance of its potato and litmus-milk cultures, by the absence of indol production, by its motility, and by the ease with which its locomotor organs could be stained. Most of these tests were gone through with in every case to make certain of the identity of the bacillus.

BRONCHO-PNEUMONIA AND FOCAL-PNEUMONIA.

The most important and extensive investigations of the bacteriology of the various forms of acute focal inflammations of the lungs are those of Finkler, Netter and Mosny. Finkler, from an examination of 37 cases

of broncho-pneumonia and other forms of acute focal-pneumonia, found that various species of bacteria occurred in these processes, but that the streptococcus was most frequently met with in the focal forms other than true broncho-pneumonia.

Netter studied 95 cases of broncho-pneumonia, 53 of which were in adults and 42 in children. Of the 53 cases in adults, 35 were mono-infections in which the micrococcus lanceolatus was found in 15, the streptococcus in 12, the bacillus of Friedlander in 9, and the pyogenic staphylococci in 3; while 14 were poly-infections with two or more of these species of bacteria. Of the 42 cases in children, 25 were mono-infections, in which the micrococcus lanceolatus was found in 10, the streptococcus in 8, pyogenic staphylococci in 5, and the bacillus of Friedländer in 2; while 17 were poly-infections with two or more of these species of bacteria. Netter concludes from his study, that neither in children nor adults is there any relation between the species of bacteria and the type of inflammation in the lung.

Mosny studied 17 cases and found the streptococcus in 11, in five cases accompanied by other bacteria; the micrococcus lanceolatus in four, and the bacillus of Friedlander in one case. Three of Mosny's cases were pseudo-lobar and in these the micrococcus lanceolatus was present.

In the course of this work cultures have been made from the lung in 16 cases in which broncho-pneumonia was present, exclusive of cases of diphtheria and scarlet fever. In eight of these cases the micrococcus lanceolatus was found as the only pathogenic organism present, in two the streptococcus, in three the staphylococcus pyogenes aureus, in one the micrococcus lanceolatus and the streptococcus; and in two only the bacillus coli communis or various unknown bacteria grew in the cultures.

In two cases of atypical pneumonic consolidation the micrococcus lanceolatus and the streptococcus were respectively present.

From these results it is clear that, as in the bronchopneumonias of diphtheria and scarlet fever, the species of bacteria associated with pneumonia conditions other than the lobar type are subject to great variation.

Of other pathological conditions in the lung, from which cultures have been made, tuberculosis only will be considered. In all of five cases of various types of pulmonary tuberculosis either the streptococcus or the staphylococcus pyogenes aureus, or both, have been found in the diseased lung. From one of these cases the bacillus diphtheriæ was also isolated, and found to be characteristically virulent for a guinea-pig. No examination was made of the throat or trachea at the autopsy, for there was no suspicion of diphtheritic infection.

THE BOSTON
MEDICAL AND SURGICAL JOURNAL.

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PUBLISHED BY DAMRELL & UPHAM,

283 Washington St., Boston.